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Factors affecting the population of raptorial birds on Sauvie Island, Oregon

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This study is an analysis of the various factors affecting the population of raptorial birds on Sauvie Island, Oregon. A census of diurnal and nocturnal raptors was carried out along with an analysis of food habits. Once the major prey species were determined they were censused and the effects of the land management practices on their numbers was investigated. In addition, 100 randomly selected nest boxes were sampled so as to determine the extent to which raptors were making use of them. Red-tailed Hawk and Great Horned Owl nests were located.

It was found that four diurnal raptors and three nocturnal raptors were present in sizeable numbers on Sauvie

Island during the winter and spring of 1972. In addition there were less common sightings of four diurnal and one nocturnal raptor.

The most common food item of raptors in general was the vole, Microtus townsendi, which was later found to be present in extremely high numbers.

The common practice of planting fields of grains and the intentional flooding of them (for waterfowl use) was found to be a major factor in the numbers and vulnerability of Microtus townsendi.

Ducks were a common food item for all raptorial species during and immediately after duck hunting season, but not at any other time of year which seemed to indicate that the raptors were feeding on carrion or wounded ducks.

It was found that Barn Owls (Tyto alba), Screech Owls (Otis asio) and Kestrel (Falco sparvarius) made use of the nest boxes on Sauvie Island.

The overlapping of food habits of Sauvie Island raptors was discussed and an attempt was made to reconcile the apparent contradiction to Gause's Rule.

FACTORS AFFECTING THE POPULATION OF RAPTORIAL BIRDS ON SAUVIE ISLAND, OREGON

by
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TO THE OFFICE OF GRADUATE STUDIES:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

For a number of years scientific journals as well as popular literature have reported that the raptors, or birds of prey, are on the decline both in the United States and worldwide. Ferguson-Lees (1963) documented declining numbers of European raptors and listed habitat destruction, poisoning by pesticides and industrial pollutants and shooting by hunters as the major causes of the decline of European raptors. Dewitt and Buckley (1955) in their study of the Bald Eagle (Haliaecetus leucocephalus) in North America, and Spitzer (in Zimmerman 1971) in his study of the Osprey (Pandion halliaetus) in Eastern North America both found chemical pollutants of one type or another to be the cause of the declining numbers of these two species of raptors. Birds of prey, like all other predators, feed near the top of food chains and are therefore subjected to the highest levels of chemical toxicants that are concentrated at each level of the food chain (Peterson, in Grossman and Hamlet, 1964). There have been documented reports of chemical pollutant residues found on analyses in the bodies of Buzzards (Buteo buteo), Sparrow Hawks (Accipiter nisus), European Kestrels (Falco tinnunculus), Peregrine Falcons (Falco peregrinus), Bald Eagles (Haliaetus leucocephalus), Long-eared Owls (Asio otus), Tawny Owls (Strix aluco), Little Owls (Athene noctus), and Osprey (Pandion

haliaetus), (Cramps 1963; Dewitt and Buckley 1955; Jeffries and Prestt 1966; Zimmerman 1971).

In addition to the pesticide problems, birds of prey are faced with the problem of habitat destruction caused directly or indirectly by man's growing numbers and the spreading of cities into once natural areas.

The references cited above paint a very gloomy picture for the future of the raptors. At a time such as this it is important that healthy, productive raptor populations and their habitats be identified and studied so that as much information as possible can be obtained about the ecology of the various species of raptors and of their environment. Hopefully, with increased knowledge of the factors that constitute good raptor habitat steps can be taken to preserve suitable habitats and encourage the increase of these magnificent birds.

The purpose of this study was to examine some aspects of the ecology of Sauvie Island, an extremely productive raptor habitat located ten miles from Portland, Oregon at the confluence of the Columbia and Willamette Rivers(Figure 1). Specifically, I sought to determine the size and species composition of the raptor population and to identify the features of Sauvie Island that allow it to support the great diversity of species and numbers of individuals as reflected in the findings of the annual bird count conducted by the Portland Audubon Society (see Appendix I).

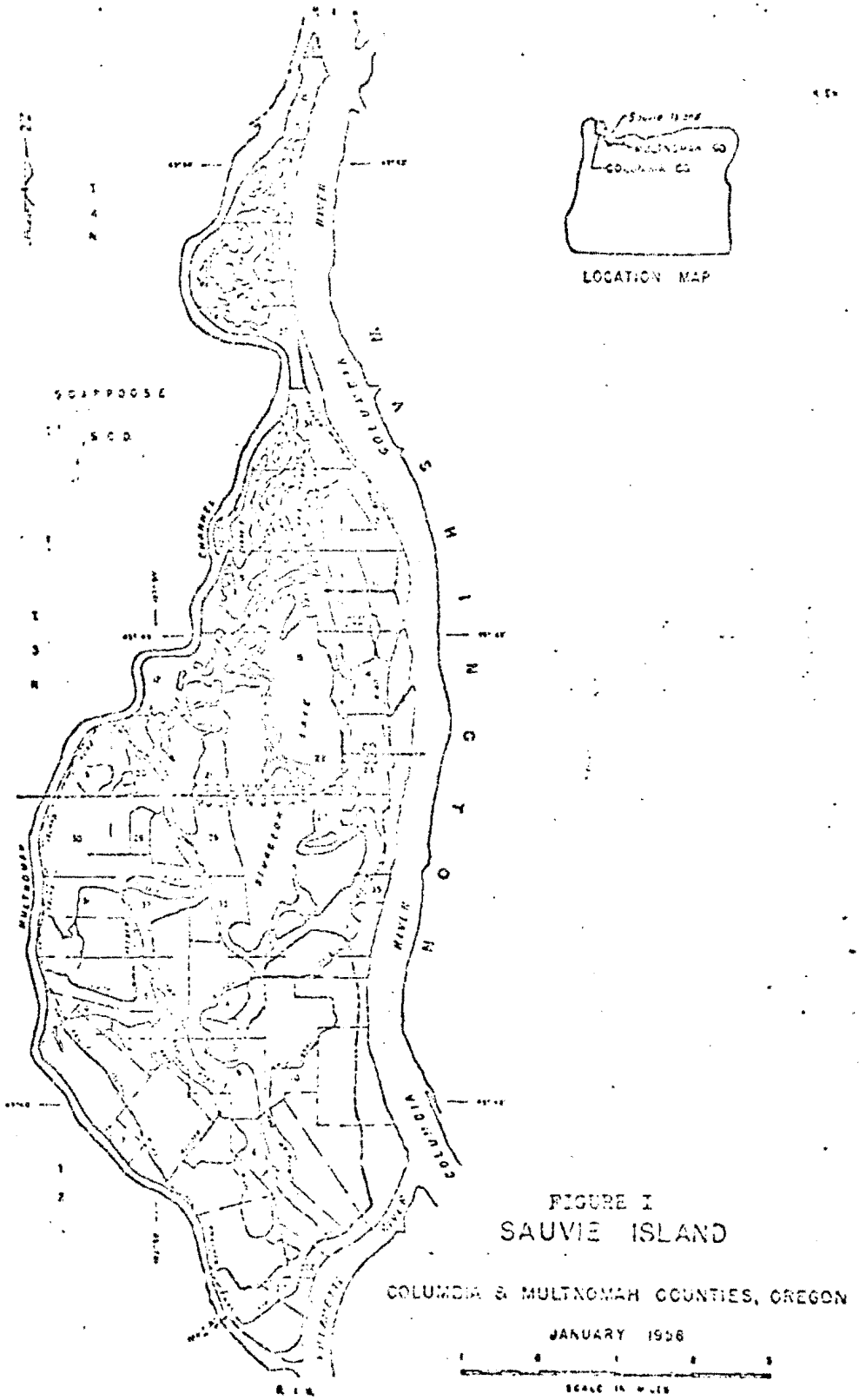

FIGURE I
SAUVIE ISLAND

COLUMBIA & MULTNOMAH COUNTIES, OREGON

JANUARY 1956

MATERIALS AND METHODS

Description of the Study Area with Special Reference to Those Features Believed to be Especially Important to the Raptor Population

More than half of Sauvie Island is owned publicly and managed by the Oregon State Game Commission as game management areas for migratory waterfowl. (See Appendix II for a complete list of waterfowl species recorded as stopping at Sauvie Island.) Also resident to Sauvie Island are many species of mammals. Among the species of mammals that constitute potential raptor prey are Vagrant's Shrew (Sorex vagrans), Townsend Mole (Scapanus townsendii), Townsend's Vole (Microtus townsendii), Eastern Cottontail (Sylvilagus floridanus), California Ground Squirrel (Spermophilus californicus), Opossum (Didelphis marsupialis), Long-tailed Weasel (Mustela frenata), Muskrat (Ondatra zibethicus) and domestic feral cats. Those mammals found on Sauvie Island that constitute potential competition for food (rodents, birds and carrion) include the Coyote (Canis latrans), Red Fox (Vulpes fulva), Long-tailed Weasel (Mustela frenata), Racoon (Procyon lotor) and Opossum (Didelphis marsupialis).

As part of their program of habitat improvement the Game Commission plants large tracts of land to crops which are

left standing and some of which are intentionally flooded for the waterfowl. Many farmers on the Island also engage in similar management practices, attracting waterfowl to their land and then selling the right to hunt them. Between the Game Commission and the farmers a total of approximately 2200 acres of land is planted for waterfowl and of this land more than half is flooded in the fall. Barley, Sudan, Prosso Millet, Fall Barley, Buckwheat, Duckwheat, Smartwheat, Potatoes, Jerusalem Artichokes and Corn are among the crops planted.

In addition to the cultivated species of plants, Sauvie Island hosts many species of native plants. Peck (1941) said of the vegetation of the Willamette River Valley, "The total number of shrubs and herbaceous plants is large, but there are few that are particularly characteristic of this area." Among the cultivated fields on Sauvie Island are woodlots consisting mainly of Black Cottonwood (Populus trichorcarpa), Oregon Ash (Fraxinus latifolia), Oregon Oak (Quercus garryana) and Red Willow (Salix lasiandra). The Oaks represent the remnants of a large stand that was logged in 1945. Among the drainage canals and in the wet, undiked areas are Black Hawthorne (Crataegus douglasii), Western Red Dogwood (Cornus occidentalis), Blackberry (Rosa laciniatus) and Bitter Cherry (Prunus emarginata). Surrounding many of the fields are fence rows of Clustered Wild Rose (Rosa pisocarpa). Peck (1941) provides a more complete list of plant species.

Sauvie Island is a very low-lying area (maximum elevation

50 feet above sea level.) Thus, parts of the Island are frequently covered by the fluctuating water levels of the Columbia River. A levee system of canals and tiled fields was constructed on the Island in 1942 to provide for drainage of flood waters. At the mouth of the Gilbert River (Figure I), the main drainage waterway, is a pump station with the capacity to pump 200,000 gallons per minute. It is this same system of canals and pumps that is used to flood selectively certain fields during waterfowl migration season.

Much of the Island is protected from flooding by the levees; however, there are still large fields in the vicinity of Sturgeon Lake and on the north end of the Island that flood seasonally when the water level of the Columbia exceeds the 16 foot mark which represents the flood stage for Sauvie Island. Figure II illustrates graphically maximum, minimum and mean of the daily high water levels for a twenty year period by the U.S. Army Corps of Engineers at their recording guage at Vancouver, Washington, a few miles up-river from Sauvie Island. As can be seen from Figure II, the flooding that took place on Sauvie Island the year of this study (1972) was not an uncommon occurance, but rather a more or less predictable, seasonal occurance.

Procedures and Equipment

The study was conducted in three phases. Phase I entailed a census and food habit study of diurnal raptors. Phase II entailed locating and identifying nests of Great

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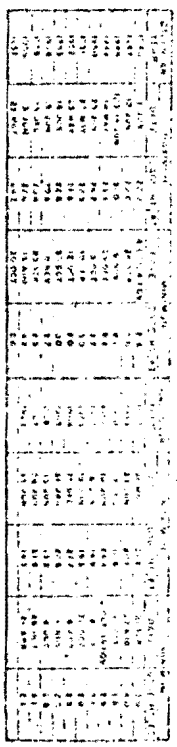


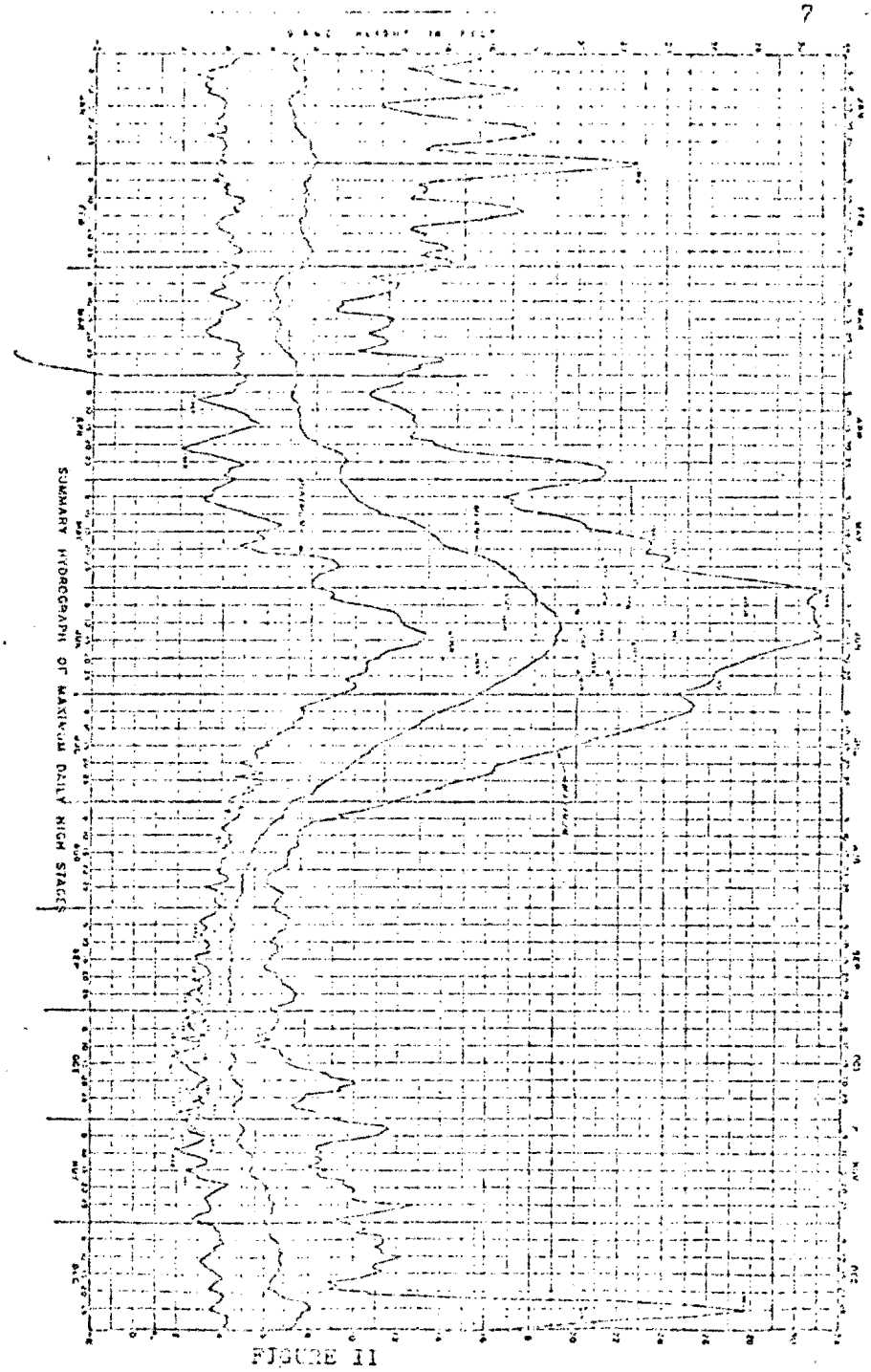


FIGURE II

Columbia River Daily High Water
Reading at Vancouver, Washington.

Horned Owls and Red-tailed Hawks and sampling 100 of the more than 300 nesting boxes found on Sauvie Island. Phase III entailed a population study of the major raptor prey species.

Phase I began on January 13, 1972 and continued until March 16, 1972. It involved a census and food habit study of Redtail Hawks (Buteo jamaicensis), Kestrel (Falco sparvarius), Bald Eagles (Haliaecetus leucocephalus), March Hawks (Circus cyaneus) and Short-eared Owls (Asio flammeus). In addition, note was taken of any rare or uncommon raptors that were positively identified in the study area during a phase of the study.

The census was conducted from a car which was driven over the entire roaded area of Sauvie Island (approximately 40 miles) at no faster than 30 miles per hour. Census trips were made twice weekly over two of three possible routes between the hours of 9:00 AM and 1:00 PM. All raptors sighted and their locations were recorded. Tasco 7X35 wide angle binoculars and a Swift Model No. 821 (30X) spotting scope were used in the identification of birds and in Phase II for the location of raptor nests.

Food habits were studied as follows. Once a week the ground under and adjacent to frequented perches was carefully searched for pellets. All pellets were collected and placed in labeled bags for later laboratory identification of contents, as done by Errington (1930). Whenever possible hunting birds were observed and an attempt was made to determine

their prey. These observations were particularly important in the case of the Redtail Hawks and Marsh Hawks because these species digest most of the bone of their prey making the pellets of little help in determining food habits, especially in a quantitative sense (Errington 1930).

Phase II of the study which began in February 1972 and continued through early June 1972, involved location and identification of Redtail Hawk and Great Horned Owl nests. During the winter the Redtail and Great Horned Owl nests of previous years were easily located, being very large and situated high in the branches of bare deciduous trees. These nests were closely watched for signs of nesting activity. In addition, new nests were located as the mating Redtails and Great Horned Owls constructed them.

In addition, 100 of the more than 300 nesting boxes, which were previously fastened to the trees at various points throughout the Island by the Oregon State Game Commission, were examined in order to determine the degree to which raptor species were making use of them for nesting or, as in the case of the owls, roosting.

Phase III of the study was conducted in the months of January and February, 1972, the time of man-made flooding and during the months of May and June, the time of natural flooding. This part of the study included calculation of a population index of the major prey species, and assessment of the effect that the fluctuating water levels had on their numbers and vulnerability. Also included in Phase III

was a determination of the species composition and census of owls, other than the Short-eared Owl which was included in the census of diurnal raptors.

During the winter and spring of 1972 when the water levels on the Columbia River fluctuate greatly, Museum Special traps were employed in fields that were in the process of draining so as to determine how long it took for rodent populations to re-establish themselves in the previously inundated fields. Rodent latrines and runways were also used as indicators of the presence and relative numbers of rodents.

When flooding was at its peak, a study was made of relative population densities of Microtus in study areas immediately adjacent to flooded fields compared to those in protected, non-flooded areas. An area 100 paces long by 60 paces wide was staked out. Twenty sampling points were located in each study area using a random number table to determine the number of paces to be stepped off down the middle of the area. A coin was flipped to determine a turn to the right or the left and then a random number determined the number of paces to move to the right or the left. This method made it equally probable for any given point in the study area to be selected for analysis. At the sampling points stakes were driven into the ground around which circles five feet in radius were circumscribed. Within these circles the presence and numbers of runways was noted and all rodent burrows, fresh latrines (it takes approximately three days

for the rodent droppings to become dark in color) and freshly nibbled bunches of grass, characteristic of Microtus were counted. This method was applied in two fields adjacent to flooding and two fields not adjacent to flooding. (Note: Census method suggested by Warren Aney of U.S.G.C.).

The census and species composition study of nocturnal raptors was carried out using a Uher 400 Report-L tape recorder playing owl calls taken from a commercial recording (Gunn and Kellogg 1962). When the calls were played within hearing range of most species a response was elicited. The routes described in Phase I were driven once a week during February and March for the Great Horned Owl census and in April through June for the remaining species, including Screech Owls (Otus asio) and Saw-whet Owls (Aegolius acadica) and Barn Owls (Tyto alba). Since Barn Owls didn't respond as dependably to the recordings as the other two species the Barn Owl census was based mainly on sightings of their roadside hunting perches and their presence in barns during the daytime. At one mile intervals a recording of one species was played five times with thirty second pauses in between playings to listen for responses. Recordings of some of the responses were made and were used to locate other owls "in the local dialect." The numbers and approximate location of responses were noted. If any other species of owl was heard calling then it was also noted and usually a recording of the species in question was played so as to keep the bird in the area until a sight identification could be made. The

Saw-whet Owl found in the study was located in this way when it responded to a Screech Owl call. In all cases, where there was some doubt as to the species of owl making a given call, an attempt was made to lure the bird out into the open where positive identification could be made with the aid of a six volt spot light.

RESULTS

Phase I

Red-tailed Hawks

After eight census trips it became apparent that each of the 16-18 Red-tails frequented a certain hunting area. As can be seen from Table I, not every Red-tail was observed on every census trip. However, enough overlapping observations were made so as to be able to identify individual birds by means of their locations.

Due to their large size and their habit of perching more than 25 feet above the ground in Black Cottonwood, Oaks, Willows and Oregon Ash trees all of which were bare during the study, the Red-tails were the most conspicuous raptors on Sauvie Island.

Rough-legged Hawks

On four occasions Rough-legged Hawks were observed in the study area. Their white heads, large size and habit of pumping their wings and hovering made the Rough-legs easily identifiable. Due to the spotty nature of Rough-leg observations no food habit information was obtained for this species.

Kestrels

Fourteen Kestrels were regularly observed hunting from the powerlines that line the roads and the perimeters of the fields. Not every Kestrel was observed on every trip

but enough overlapping observations were made to permit identification of at least fourteen individuals.

Bald Eagles

Three Bald Eagles, two adults and one immature bird were regularly observed in the area of Sturgeon Lake. The Eagles had two favorite perching trees, a large Oregon Ash and an Oak, both of which were located on Oak Island (see Figure I). At the base of these two trees was found the accumulated remains of the Eagles' prey which seems to indicate that the Eagles had made use of these perches for some time. On two occasions all three Bald Eagles were observed while perching together in the same tree.

Sharp-shinned Hawk

One sharp-shinned Hawk was observed in the study area on February 19. This was the only sighting of a Sharp-shinned Hawk in the study.

Merlin

On December 7 a Merlin was observed and photographed in a snag along a roadway in the study area.

Harriers

At least two or three Harriers were observed on most census trips and the maximum number observed in one day was seven. However due to the Harriers' hunting and perching habits they were one of the most difficult of the Sauvie Island diurnal raptors to census accurately. Therefore the Harrier census may be a bit conservative. (See Discussion, Phase I).

Short-eared Owls

As can be seen from Table I the Short-eared Owl observations were spotty. However, at least once during most weeks for the duration of the study one to as many as three Short-eared Owls were observed. Like the Harrier, the Short-eared Owls' perching and hunting habits make it a difficult bird to census accurately. Therefore the Short-eared Owl census may also be a bit conservative. (See Discussion, Phase I.)

Ferruginous Hawk

A Ferruginous Hawk was observed and photographed on April 20. It was perched on a powerline pole and did not fly off until I had stopped my car, gotten a good look at the bird and taken a few photographs.

The findings of the final part of Phase I, the food habit study are summarized in Table II.

TABLE I

Census Data for Diurnal Raptors on Sauvie Island, December 1971-March, 1972

Date	RT	H	K	SEO	E	RL*	FH*	M*
Dec. 7	17	6	13	0	1			
Dec. 23	16	7	15	0	1			
Dec. 24	19	4	11	2	2			
Dec. 30	15	3	12	3	0			
Dec. 31	20	4	14	2	3			
Jan. 13	19	5	12	1	0			
Jan. 14	21	3	9	3	3			
Jan. 20	20	5	11	3	1			
Jan. 21	19	4	10	2	0			
Jan. 29	23	5	15	1	3			
Jan. 30	17	2	12	0	0			
Feb. 3	26	3	14	2	1	1		
Feb. 8	10	2	13	0	0			
Feb. 12	17	2	12	0	0	2		
Feb. 13	16	2	11	2	0			
Feb. 17	12	3	10	0	0	1		
Feb. 19	11	0	7	0	0	1		1
Feb. 24	14	7	17	2	0			
Mar. 2	13	4	17	2	0			
Mar. 3	28	4	11	3	0			
Mar. 8	Rain--Poor Visibility							
Mar. 9	Rain--Poor Visibility							
Mar. 11	18	3	12	1	0			

TABLE I (Continued)

Date	RT	H	K	SEO	E	RL*	FH*	M*
Mar. 15	22	1	9	0	0			
Mar. 16	21	3	7	3	0			
April 20							1	

KEY TO SYMBOLS OF TABLE I

RT= Red-tail Hawk

H= Harrier

K= Kestrel

SEO= Short-eared Owl

E= Eagle

RL= Red-legged Hawk

FH= Ferruginous Hawk

M= Merlin

* indicates four or fewer sightings

TABLE II

Raptor Food Habits as Determined by Prey Remains in Pellets and Observations of Kills

Raptor Species	Prey	% Occurance in Pellets or of Observed Kills
Red-tailed Hawk	Sylvilagus floridanus	12%
	Microtus townsendii	65%
	Spermophilus beecheyi	15%
	Corvus brachyrhynchos	12%
	Passerine sp.	6%
	Didelphis marsupialis	3%
	Ducks	3%
Kestrel	M. townsendii	64%
	Insects	24%
	Passerine Sp.	15%
	Peromyscus	2%
	Frogs	2%
	Ducks	6%
Bald Eagle	Ducks	100%
	Carp	20%
Barn Owl	M. townsendii	100%
	Ducks	5%
	Sorex vagrans	4%
	Insects	1%
	Passerine Sp.	.9%
	Frogs	1%
	Scapanus townsendii	2%

TABLE II (Continued)

Raptor Species	Prey	% Occurance in Pellets or of Observed Kills
Screech Owl	M. townsendii	45%
	Passerine Sp.	20%
	S. vagrans	20%
	Frogs	8%
	Ducks	.9%
	Insects	20%
Great Horned Owl	M. townsendii	30%
	Ducks	14%
	D. marsupialis	5%
	S. floridanus	20%
	Carp	6%

Phase II

A total of 18 Redtail Hawk nests were located in the study area. Nine of the nests were built in past years and were located prior to March 11, which was the earliest date that Redtails were observed in nest building activities. Subsequent to March 11 nine new Redtail nests were found. These nests were built 60 feet or more from the ground, usually in Black Cottonwood trees although nests were found in Oregon Ash and Oaks as well. Due to the great height and general inaccessability of the nests I was unable to examine the nests closely.

Five Great Horned Owl nests were located on Sauvie Island. Three of the five nests were located when the male Great Horned Owl was flushed from his daytime perch located close to the nest. In two cases male Great Horned Owls were found on the ground directly under the nest.

Nest Box Survey

Of the one hundred boxes examined seven were found to contain Screech Owls (i.e. the Owls were in the box when it was opened), another seven contained Screech Owl pellets, five contained Barn Owl nests, another nine contained Barn Owl pellets and four contained Kestrel Nests.

Barn Owls made use of the boxes during the winter as daytime perches and then nested in them during the spring. Some of the boxes showed signs of long term occupancy. One box contained 580 Microtus skulls in addition to an assortment of shrews, moles and passerine bird remains, while

another nest contained the remains of a nestling Barn Owl. In both of these boxes new nesting took place in the spring of 1972. The nest boxes were too small for both members of a pair of Barn Owls. However, in two cases male and female Barn Owls were found in adjoining nest boxes on the same limb of a tree.

Screech Owls also made use of the nest boxes for perching and nesting. In some cases the Screech Owls made use of more than one box during the winter. In two instances where clusters of nest boxes were repeatedly sampled certain individual Screech Owls were found in every box in the cluster at one time or another. It is also of interest to note that Screech Owls nested for at least two years in natural cavities and hollows in trees that also contained nest boxes. In both instances, however, the Owls spent the winter perching in the nest boxes when the hollows were filled with water from the almost daily winter rains.

Four Kestrel nests were found in nest boxes. Like the Barn Owls and the Screech Owls, Kestrels normally nest in hollows and natural cavities in trees.

Phase III

Population Index of Major Prey Species

Ducks--The Oregon State Game Commission records show that approximately 20,000 waterfowl are bagged each year by hunters (Annual Report of the Game Division, O.S.G.C.). Furthermore, it is estimated that 20% of the birds shot are wounded and die at a later time, never actually bagged by the hunter

(John Chattin, Bureau of Sport's Fisheries and Wildlife). In addition, there are still more waterfowl that succomb to lead poisoning caused by the ingestation of shot while dabbling in the mud (Chet Kebby, O.S.G.C.). This suggests that on Sauvie Island approximately 5000 dead and wounded ducks may be available during and just after hunting season for consumption by raptors or other opportunists.

Microtus--During the winter months when the fields were relatively barren, the runways used by the Townsend's Vole (Microtus townsendi) and the Vagrant Shrew (Sorex vagrans) became apparent almost everywhere in the study area. The fields took on the appearance of giant leaves with veins running out in all directions.

Although both species made use of the runways, Microtus became the species of interest due to its high occurance in the pellets of all resident raptors.

Table III gives the results of trapping and observations in previously flooded fields for five days following draining of superficial water. As can be seen from Table III quite a sizeable Microtus population had migrated from the lush vegetation in areas adjacent to flooding to the relatively barren habitat of the previously flooded area.

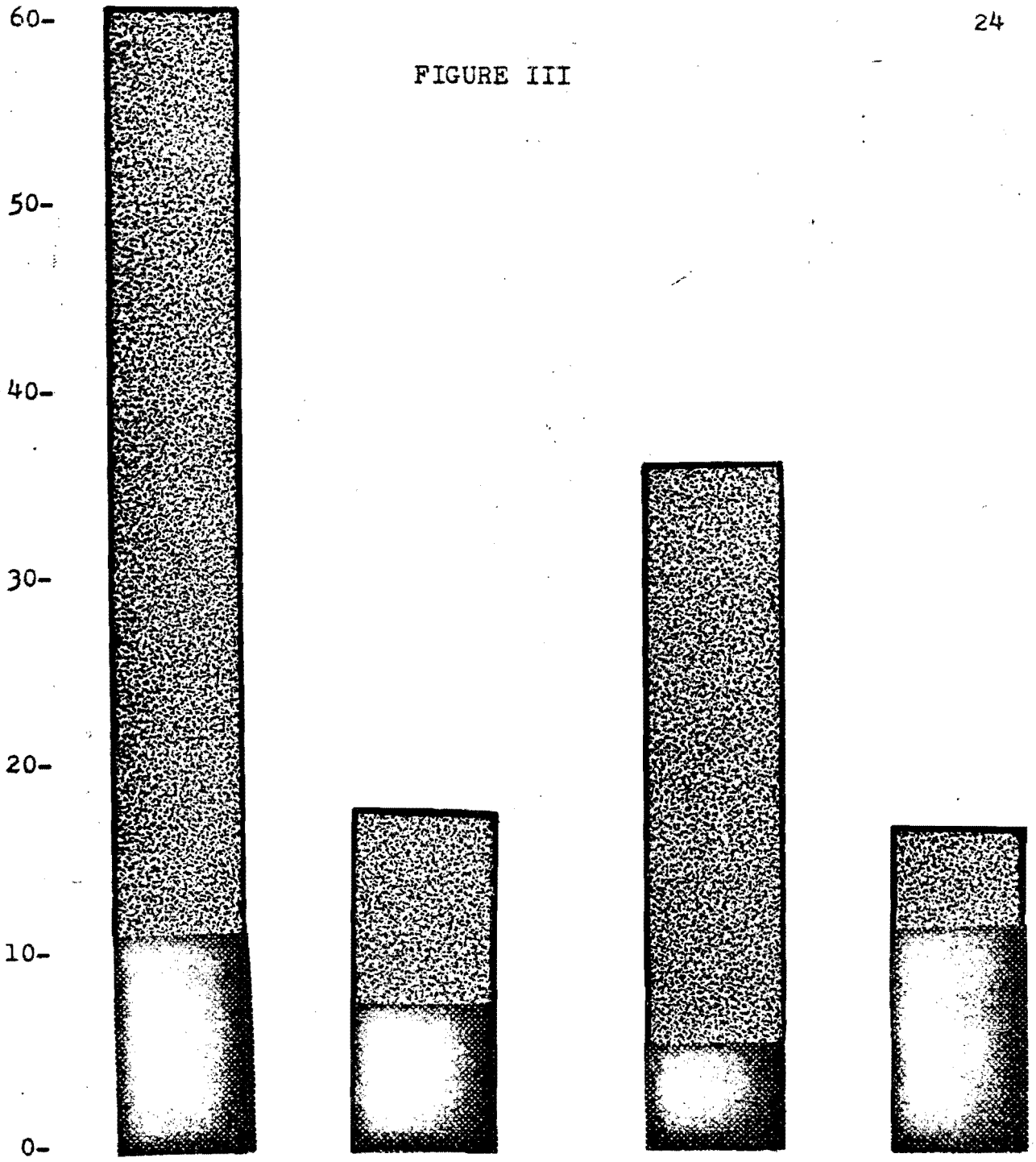
Figure III gives the findings of indicators of Microtus activity in fields adjacent to flooding and fields not adjacent to flooding. Evidence of Microtus activity was found in all twenty sample plots adjacent to flooded areas. As was previously stated in the Methods section, the sample

TABLE III

Results of Trapping (30 Traps) and Observations (30 Samples) in Previously Flooded Fields for Five Days Following the Draining of Above-Surface Water.

Day	# Latrines	Trapping Results
1	3	None
2	7	1-*Sorex vagrans*
3	18	2-*Microtus townsendi*
4	25	None
5	28	2-*Microtus townsendi* 3-*Sorex vagrans*

FIGURE III



Four measurements of rodent activity in fields (1) adjacent to and (2) not adjacent to flooding.

(1)=

(2)=

plots were 78 square feet each. Using an estimate of two Microtus per plot (which seems reasonable due to the number of runways, latrines, etc. and extrapolating I arrived at an estimate of 558 Microtus per acre.

Owl Census--Table IV gives the estimated populations of four of the five Owl species found on Sauvie Island. The fifth species, the Short-eared Owl was included along with the diurnal raptors in Phase I.

TABLE IV

Species Composition and Census of Owls on Sauvie Island

Species	Number of Individuals
Barn Owl	16
Screech Owl	20
Great Horned Owl	12
Saw-whet Owl	2

DISCUSSION

Phase I

Red-tails

Gabrielson and Jewett (1940) noted that the Red-tail was the most common large hawk in Oregon. This was also found to be the case on Sauvie Island where six or seven Red-tails could sometimes be seen along a mile stretch of road during the winter months. Craighead and Craighead (1961) observed that Red-tails maintained regular winter ranges but did not defend them in a territorial manner as is the case during breeding season. Consequently, the winter ranges often overlapped. On Sauvie Island during the winter of 1972 there were often times areas of high concentrations of Red-tails. For example, on 29th of January eleven Red-tails were observed in less than three miles of driving along Oak Island Road (Figure 1); that same day seven Red-tails were observed from the top of the dike along Little Sturgeon Lake.

Hamlin and Grossman (1964) noted that high raptor concentrations may often reflect high concentrations of prey. Starting three days before the hurricane of 1938 in New England, Hamlin and Grossman reported seeing large numbers of rodents crossing roadways and climbing hillsides, possibly in response to the falling barometer.

Also during this period of time they reported seeing large numbers of Red-tail Hawks.

Considering the fact that eighteen active Red-tail nests were eventually found on Sauvie Island it seems quite likely that most of the winter population remained on Sauvie Island and nested there.

Rough-legged Hawks

The Rough-legged Hawks nest in the Arctic and are believed to migrate south in response to fluctuating lemming (Synaptomys spp.) and Snowshoe Hare (Lepus americanus) populations (Lack 1954). The four observations of Rough-legged Hawks probably represented one or two southward wandering individuals.

Because of the sparcity of Rough-leg observations no food habit data was obtained for this species.

Kestrels

Gabrielson and Jewett (1940) said of the Kestrel, "This handsome little falcon is without doubt the most abundant raptorial bird in the State and is a familiar sight to most travelers as it perches on the telephone poles along the highways, now and then darting to the ground to get a mouse, a beetle, or a grasshopper detected by its keen eyes." On Sauvie Island, the Kestrel is second only to the Red-tail in abundance and as was observed by Gabrielson and Jewett they can often be observed perching on powerlines. In the study area there are powerlines that stretch across and around the perimeter of the cultivated fields where prey

is abundant. Being the smallest of the diurnal raptors, the Kestrels are the only species small enough to effectively make use of the powerlines as hunting perches. It is quite possible that the presence of the powerlines in prime hunting territory has contributed to the success of the Kestrel on Sauvie Island.

Harriers

Harriers were a most difficult bird to census accurately. They are reported to have one of the largest winter ranges of all the North American raptors (Craighead and Craighead 1969). One Harrier was flying parallel to a roadway and was kept in sight for four and a half miles. An added complication in the Harrier census was their habit of perching on the ground, out of sight in a normal census situation. Craighead and Craighead (1969) found that the Harriers in their study area in Michigan spent an average of 57% of their time on the ground. To compensate for this shortcoming the Craigheads carried out a foot census in a number of areas that they had previously censused by car and then comparing both census figures calculated that the car census figures should be multiplied by 2.3 to give a more accurate estimate of the number of Harriers. I made no quantitive studies of the amount of time that Harriers spent on the ground. However, 17 of the 41 Harriers recorded in the census were on the ground and the remaining birds were flying close to the ground and were not visible at a long distance. Therefore it is quite possible that the

Harriers also nest on the ground which is a disadvantage in an area of periodic flooding during nesting season. This is probably the reason why Harriers are not known to nest on Sauvie Island.

Bald Eagles

Gabrielson and Jewett (1940) reported that the Bald Eagle was becoming rare in Oregon. However, they made special mention of the Columbia River Valley as a place where Eagles were fairly regularly observed.

On Sauvie Island the Eagles' presence at Sturgeon Lake coincided with the influx of large numbers of migrating waterfowl which constituted their major food source.

Short-eared Owls

The Short-eared Owls are listed by Bent (1937) as permanent residents of Oregon. However, like the Harriers they are ground perching and ground nesting birds which makes survival on Sauvie Island during nesting season a most difficult if not impossible task due to the flooding of many of the fields.

Because of their ground perching habit the Short-eared Owl is a difficult bird to census accurately. For this reason the census figures for the Short-eared Owl may be a bit conservative.

Phase II

Nest Box Survey

For many years it has been known that owls will nest in man-made structures of various sorts. People who desired

to encourage the growth of the owl population because of their fantastic mouse-catching abilities have constructed shelters for owls and even made provision for owls within the design of their own homes. In the Netherlands farmers have for years built access routes to the lofts and roof spaces in their houses. Large Friesan farmhouses often are built with a decorative complex on the roof called an "owl board" (oelegat) (Sparks and Soper 1970).

Southern (in Lack 1966) successfully used nest boxes to study the nesting behavior and population to the Tawny Owl (Strix aluca) in Great Britain and it is a common practice among wildlife conservationists to construct nest boxes for species of owls that would normally nest in the hollows of trees.

The nest boxes on Sauvie Island are primarily intended for Wood Ducks (Aix sponsa), however according to Frank Newton, Game Commission man in charge of Sauvie Island, boxes are placed in many different habitats so that they get a wide variety of residents.

Because a relatively small proprotion of the resident Barn Owls, Screech Owls and Sparrow Hawks made use of the nest boxes, it is believed that the boxes do not constitute prime nesting and/or perching sites for these species. That is, given the choice it seems that these birds choose to nest or perch in relatively dry natural cavities than in nest boxes when both are available. However, the fact that there are hundreds of available boxes suggests that no

Kestrel, Screech Owl or Barn Owl would forego mating for want of an adequate nest site. Furthermore, it seems possible that the nest boxes allow these three species to nest earlier in the year than they would in the natural hollows because all of the nests found in hollows were in the open-ended stump of large limbs that had broken off, leaving a deep, water-tight hollow pointing upward.

Phase III

Population Index of Major Prey Species

Ducks--Although ducks appeared to constitue a relatively small part of the food consumed by raptors over the course of a year, they were a common food item for all species of raptors on Sauvie Island during and for about three weeks after duck hunting season. Errington (1969) found that raptors often fed on crippled waterfowl during hunting season.

The fact that no evidence of duck feathers in raptor pellets was present four weeks after hunting season (nor was it present before hunting season) was interpreted as meaning that raptors were probably feeding exclusively on wounded ducks and carrion and were not preying upon healthy ducks. It would seem unlikely, for example, that Kestrels and Screech Owls, both of which fed on ducks, could kill healthy ducks which were swift fliers and at least twice as large as these two species of raptors.

An observation of a hunting Harrier also lends support to the claim that the raptors fed on wounded ducks. I watched

the bird in question fly from pond to pond and scare up flock after flock of ducks. The Harrier did not make any attempt to capture the ducks as they flew off. However, at one pond a duck was unable to fly off with the rest of the flock and merely splashed about in the water. The Harrier quickly swooped down, made the kill and proceeded to consume its catch.

With 5000 wounded and dead ducks available the raptors were probably not even competing with one another for prey but merely partaking of the same over-abundant "free food."

Microtus--See general discussion.

Owl Census--The census data in Table IV represent positively identified and consistently observed individuals. In some cases pairs of owls were located in their nesting areas in which case they could also be located during the day. Other individuals were located at their nocturnal perching spots and were repeatedly located after dark by the method described earlier.

Because many Screech Owls and Great Horned Owls consistently responded to the taped calls even when I was in plain sight and as close as fifteen feet, leads me to believe that the census method used was highly effective for these two species.

It is difficult to comment on the accuracy of the Barn Owl census which was based on sitting due to the fact that Barn Owls which were under observation did not respond to the recorded Barn Owl call. Also, the Barn Owls, very con-

veniently made use of the roadside fenceposts at night for hunting perches so that their white color could be very easily seen from a passing car. The twelve Barn Owls listed in the census were found to frequent certain perches as evidenced by the accumulated pellets and prey remains under certain fenceposts and in certain barns.

Only one Saw-whet Owl was positively identified in the census. This one individual responded to a Screech Owl call and was then lured on to a nearby tree where a positive identification was made. According to Gabrielson and Jewett (1940) the Saw-whet was never a commonly occuring bird in the Columbia River Valley and the census figure of two may not be far from correct. (The one bird was heard and seen during mating season therefore I took the liberty of adding a second bird to the census).

Due to the fact that there seems to be a great demand for owls as pets or specimens, I have not listed the location of the individuals that I have found.

GENERAL DISCUSSION

The combination of a number of factors makes Sauvie Island an unusually rich habitat for raptorial birds. Among these are: (1) the planting and periodic flooding of thousands of acres of crops which at first allows Vole populations to reach high numbers and then crowds them into the remaining dry land where they are exceedinly vulnerable to predation; (2) the wounding and/or lead poisoning of approximately 5000 ducks each hunting season which provides an enormous free food supply for all raptor species; (3) the ideal hunting and nesting habitat of open fields, dotted with dense stands of timber used by all species of raptors for nesting and/or perching and (4) the powerlines and fenceposts that stretch across the Island that are used by Kestrels by day andthe Barn Owls by night for hunting perches. In addition, the nest boxes provided by the Oregon State Game Commission and the barns on Sauvie Island provided hundreds of well protected perching sites for Barn Owls and Screech Owls and nesting sites for the Barn Owls, Screech Owls and Kestrels. Perhaps the nest boxes eliminate the lack of nesting sites as a possible limiting factor for the species that normally nest in hollows in trees, in addition to permitting these species to nest earlier in the year.

The results of the food habit study revealed that Townsend's Vole constituted a significant proportion of the food items of all resident species of raptors on Sauvie Island. At first glance this situation would seem to be a contradiction to Gause's Rule (1934) which is widely accepted by contemporary ecologists and has been shown to hold true for many species of birds and mammals (Lack 1944, 1945, 1946). Gause's thesis was that two species with the same ecology cannot persist together in the same region. (See Crombie (1945) for a detailed mathematical treatment of interspecific competition). However, throughout the years a number of special cases of interspecific competitions involving various predators and prey species belonging to the genus Microtus and other extremely prolific species have been documented (Errington 1935, Lack 1946, Lockie 1955). Many parallels can be drawn between the findings of the above-mentioned workers (especially Lack) and the findings of the study; for this reason Lack's explanation of the apparent contradiction of Gause's Rule in the case of certain European Raptors might also be applied to the situation on Sauvie Island.

Lack (1946) stated that "...either they (raptors) differ in habitat, in which case their hunting methods and/or the size of their prey are different." Lack reported that with only one exception no two congeneric European raptors compete for the same food supply. Furthermore, in twelve species of different genera he found no

overlap in these species. However, for five species of Strigiformes and five species of Falconiformes Lack found an apparent contradiction to Gause's Rule. The bulk of the food of these raptors consisted of the vole, Microtus arvalis. This situation appears to be nearly a direct parallel to that on Sauvie Island. It is interesting to note that three of the species in Lack's study--the Barn Owl, the Marsh Hawk and the Short-eared Owl--are also predators of a species of Microtus on Sauvie Island. In addition, Lack listed the European Kestrel (Falco tinnuculus), which is the ecological equivalent of the American Kestrel (Falco sparvarius) and the Buzzard (Buteo buteo), a congener of the Red-tailed Hawk (Buteo jamaicensis) (Grossman and Hamlet 1964).

In order to reconcile the differences between his findings and Gause's Rule, Lack put forth a corollary to Gause's Rule, that "...two species can exist together in the same habitat and eating the same food when the foods in question are temporarily so much more abundant than the requirements of the consumers that the latter do not effectively compete with each other while eating them; and this may still hold true even if the food in question temporarily provides the bulk or even the whole of the diet of the species involved." Lack also stated that the large percentage of Microtus in the prey may be "unnatural and due to man." Lack cites replacement of swamps by grasslands and cornfields as man-made changes that encourage Microtus

populations, thereby increasing the percentage of Microtus in the prey of raptors.

That overpopulation of a prey species leads to the prey species being heavily preyed upon is not a new or recent finding. McAtee (in Errington 1935) advanced the principle that "predation tends to be in proportion to population" and also postulated that the proportion rises and falls with the numbers of available food organisms. Errington (1935) specifically stated that McAtee's principle was applicable in the case "the prolific vertebrates." Lockie (1955) found that Short-eared Owls (Asio flammeus) fed almost exclusively on Microtus during what he termed a "vole plague."

The work of McAtee, Errington, Lack and Lockie lends support to the conclusions drawn from the data of the present study. The diking and draining of Sauvie Island and the cutting of Oaks and the planting of crops could make for an "unnatural" condition similar to that described by Lack (1946). The periodic flooding of many fields could then concentrate the Voles even more making them the most abundant and available raptor prey on Sauvie Island. Therefore Lack's Corollary to Gause's Rule and McAtee's Principle could very likely apply to the predation of Microtus townsendii by the various species of raptors on Sauvie Island.

An account of flooding causing an increaded vulnerability to predation in Microtus populations was reported by Izotov (In Elton, 1942). Izotov conducted an experiment whereby

a large number of voles of the species Microtus arvalis were trapped, ringed on their hind legs and then released with the hope of recovering the rings from Owl pellets that he collected at the Owls' perching sites, so as to determine the percentage of voles eaten by the Owls. No sooner had Izotov completed the ringing than the River Dnieper flooded, driving the rodents to higher ground where "Owls attacked them." Initially Izotov estimated the opoulation of Microtus arvalis at 58 per acre; after one month he estimated the population to be nine per acre, an 80% reduction in sumbers. On Sauvie Island, however, tha land and wildlife management practices that generate such large numbers of Microtus are practiced every year and baring some intrinsic cycle in the numbers of Microtus it is quite likely that Microtus numbers and density will continue to be very high during all seasons of the year with especially dense populations during times of flooding.

According to Craighead and Craighead (1969) all species of raptors in their study area (including Redtails) were closely correlated with the population(s) of their chief winter food(s). If this conclusion is true for my study area then baring any changes in management practices, Sauvie Island should continue to attract and support high numbers of raptorial birds.

APPENDIX I

List of Raptors Sighted in the Audubon Christmas Bird Census on Sauvie Island, 1967-1971.

Species	1967	1968	1969	1970	1971
Red-Tailed Hawk	54	69	81	82	61
Rough-Legged Hawk	4	5	3	2	6
Cooper's Hawk	2	4	6	1	9
Sharp-Shinned Hawk	1	2	3	2	2
Kestrel	78	86	92	102	98
Merlin	0	1	1	0	0
Peregrine Falcon	1	2	2	2	0
Gyr Falcon	0	0	0	1	0
Harrier	10	18	13	18	20
Bald Eagle	1	2	3	3	3
Barn Owls	2	6	7	11	1
Screech Owls	1	2	1	1	0
Great Horned Owls	2	11	5	11	3
Long-eared Owl	1	0	0	0	0
Short-eared Owl	4	5	4	16	2
Saw-Whet Owls	0	0	2	0	0

APPENDIX II

List of Migratory Waterfowl that are Hunted on Sauvie Island

Mallard

Am. Widgeon

E. Widgeon

Green-winged Teal

Pintail

Shoveler

Gadwall

Cinnamon Teal

Wood Duck

Ruddy Duck

Goldeneye

Bufflehead

Ringed-neck Duck

Lesser Scaup

Canvasback

Redhead

H. Merganser

Common Merganser

White-winged Scoter

Old Squaw

Canada Goose

White-fronted Goose

Snow Goose

SUMMARY

1. Four species of diurnal raptors and three species of nocturnal raptors were regularly sighted in fairly high numbers on Sauvie Island during the winter and spring of 1972.
2. Four additional diurnal raptors and one species of nocturnal raptor were less commonly identified.
3. All species of raptors for which food habit information was obtained, with the exception of the Bald Eagle, were found to feed on the vole, Microtus townsendi, during every month of the study.
4. All species of raptors fed on ducks during and immediately after duck hunting season which seemed to indicate that raptors were feeding on carrion or wounded ducks.
5. The population of Microtus was found to be extremely high especially in areas adjacent to flooding. A conservative estimate of 558 Microtus per acre was made for an area adjacent to flooding.
6. The common practice on Sauvie Island of planting fields of grain and then intentionally flooding them (for waterfowl use) was found to be a major factor in the numbers and vulnerability of Microtus.
7. During the duck hunting season approximately 700 ducks are shot, not retrieved by hunters and therefore avail-

able to raptors and other opportunists.

8. Barn Owls (*Tyto alba*), Screech Owls (*Otis asio*) and Kestrel (*Falco sparvarius*) made use of the nest boxes on Sauvie Island.

9. The high degree of overlapping in the food habits of Sauvie Island raptors was found to be very similar to cases reported for European raptors in times of high vole populations.

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